6-1944

Bulletin No. 314 - Gains Made by Cattle on Summer Range in Northern Utah

L. A. Stoddart

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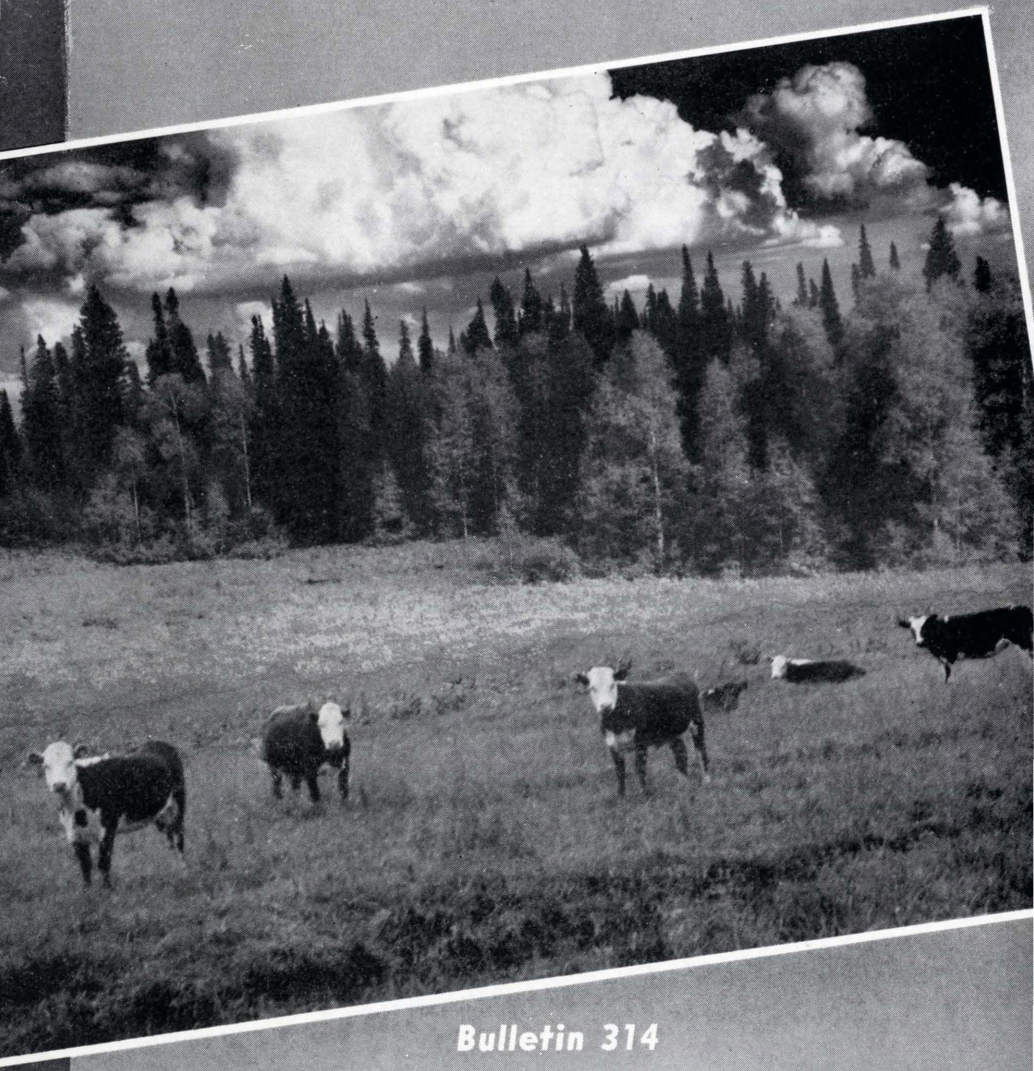

Bulletin 314

AGRICULTURAL EXPERIMENT STATION

Utah State Agricultural College

LOGAN, UTAH

JUNE, 1944

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UTAH STATE AGRICULTURAL COLLEGE
Logan, Utah

June 1944

Foreword

This bulletin is a report on certain phases of project 162 of the Utah Agricultural Experiment Station, entitled "The phosphorus content of summer range forage and its relationship to range cattle maintenance." This project was begun in 1934 under the direction of E. J. Maynard, H. H. Smith, R. J. Becraft, and J. E. Greaves in the departments of Animal Husbandry, Range Management, and Bacteriology and Biochemistry.

Those phases of the project dealing with chemical analysis of the range forage, especially phosphorus content, were reported in bulletin 305, entitled "The composition of summer range plants in Utah" and published in 1942.

Although the author is indebted to many individuals who aided in the planning and field work connected with this project, especial appreciation is hereby expressed for the help of professors H. H. Smith, A. D. Smith, and C. W. Cook. The kind cooperation of the Logan Canyon Cattle Association members who furnished the animals and of the Cache National Forest personnel who arranged for the use of the national forest lands and otherwise aided in the research is also appreciated.

GAINS MADE BY CATTLE ON SUMMER RANGE IN NORTHERN UTAH

L. A. Stoddart[1]

Introduction

THE Utah Agricultural Experiment Station, in 1934, began experimental studies on the grazing of beef steers on mountainous summer range lands. Although the direct purpose of this work was to find whether supplementing phosphorus in the diet of grazing steers would increase their gains, many incidental observations proved of great interest. Among the most significant were the distribution and extent of weight gains through the summer grazing season and the effects of various factors such as weather upon the gains, causing them to vary greatly from year to year.

Other Studies on Cattle Gains

Actually, surprisingly little is known of the gains made by cattle on Utah ranges. In 1926, the Bureau of Animal Industry published an account of gains made by Hereford cattle on mountain range east of Salina, Utah, at about 8,000 feet elevation.[2] The animals varied in age from calves to 3 years or more, though most were yearlings to 2-year olds. Over a season generally from June 1 to October 1, these animals averaged gains of 41.05 percent of their starting weight, the average gain varying in different years, from 33.1 to 52.1 percent. In pounds per animal, the gain averaged 255.1 for the season or 2.43 pounds per day. The rate of gain was most rapid in the early season and gradually diminished in the fall. In 4 of the 9 years reported, small losses occurred after about mid-September but, under "average" conditions, gains continued until the last weighing which was usually the last week in September.

The Pastures

THE two pastures used in this experiment, approximately 200 acres each, are located 20 miles east of Logan in the northern extreme of Utah. They were fenced from the national forest range in 1934, and under a conservative grazing program, the range has improved until it now is noticeably more productive than the outside range.

The pastures are of steep topography and they are both rather more "brushy" than average summer range. Otherwise, they are typical of millions of acres of mountain summer range in the Rocky Mountain area. The pastures are well watered by natural springs and water is never limited. The vegetation is largely sagebrush and aspen type

[1]Research professor of range management

[2]Clawson, A. B. Normal growth of range cattle. U. S. Dept. Agr. Bul. 1394. 1926

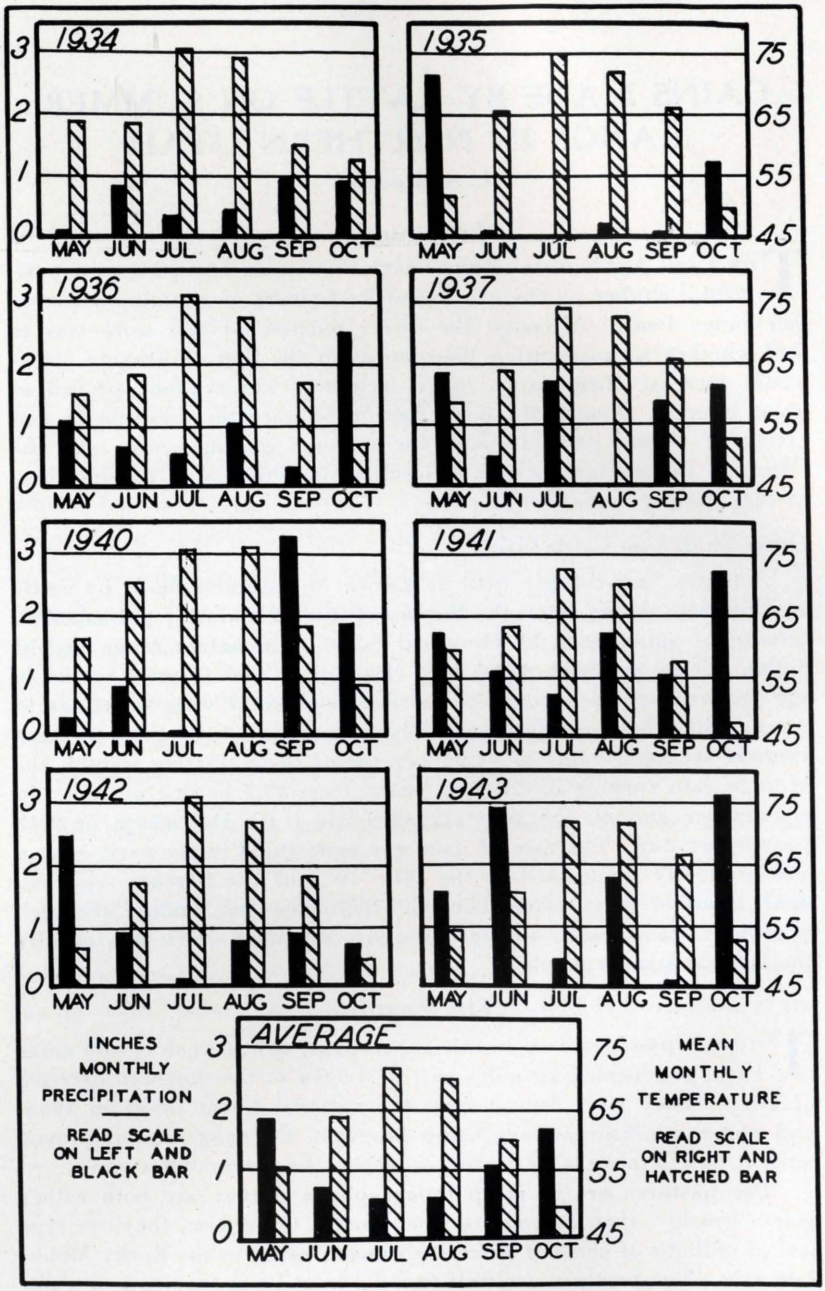

Fig. 1. Precipitation in inches and mean temperature in degrees F. at Logan, Utah, 20 miles west of the experimental area. Quantitatively these do not represent weather at the pastures but relationships between months and years are considered representative of the pastures (Data from U. S. Weather Bureau)

but both types support a dense undercover of shrubs, grasses, and other herbs.

Weather

The elevation averages approximately 6500 feet and precipitation is about 21 inches per year. The precipitation is distinctly of the "winter" type, two-thirds coming in the non-growing season (November to April) and one-third in the growing season (May to October). July and August are especially dry. A 3-year record taken at the pastures shows averages of 0.83 inches for July, 0.44 inches for August, 2.36 inches for September, and 1.69 inches for October.

Although no temperature records are available for the pastures, the summer temperatures are typical of the high mountains of the West, moderately high during the day in midsummer but cold at night. Fall temperatures reach freezing levels generally during September, and October is often bitterly cold.

Complete climatic records are available in Logan at an elevation of 4778 feet and 20 miles west of the pastures. Although these records are not comparable quantitatively with the climate at the pasture, it is believed that the monthly and annual relationships are reasonably applicable. Precipitation and mean temperature records at Logan during the growing season, May to October, are shown in figure 1. Additional weather conditions for the years concerned in the experiment are shown in table 1.

Table 1. *Weather records at Logan, Utah, 20 miles west of the pastures* (Data from U. S. Weather Bureau.)*

Year	1934	1935	1936	1937	1940	1941	1942	1943	Long-time average
Total annual precipitation (inches)	11.79	13.47	18.31	20.41	17.05	19.62	17.97	18.12	16.53
Mean temperature (degrees F.)	53.2	48.9	50.1	48.4	51.6	48.4	46.7	49.5	47.6
January to September precipitation	7.71	10.00	13.24	14.96	12.02	13.09	13.06	13.46	12.23
May to September precipitation	2.69	3.25	3.83	5.49	4.41	6.44	5.15	6.71	5.23
September and October mean temperature	57.0	58.4	56.9	59.8	58.5	52.4	56.8	59.5	55.5
March to June mean temperature	57.9	50.7	54.0	50.6	56.0	52.3	48.5	51.9	50.7

*Quantitatively these records do not represent weather at the pastures but relationships between years are considered representative of weather at the pastures.

Fig. 2. Animals entering the college pastures. Note the vegetation and topography typical of the area

Vegetation

As is typical of western mountains, the soil and topography of the pastures are heterogeneous, hence the vegetation is complex (fig. 2). A total of 123 flowering plant species occur in appreciable quantity.

Detailed plant surveys repeated in four years showed, by conservative estimate, 22.3 percent of the ground covered by vegetation and a 0.078 forage acre factor.[3] The vegetation is classed as 69.0 percent aspen type, 29.5 percent sagebrush type, and 1.5 percent as willow-meadow bottomland. The most abundant forage species and the percent each contributes to the vegetation composition are as follows:

		percent
Roundleaf snowberry	*Symphoricarpos rotundifolius*	15.6
Western chokecherry	*Prunus melanocarpa*	8.7
Serviceberry	*Amelanchier alnifolia*	7.5
Aspen	*Populus tremuloides*	5.2
Big sagebrush	*Artemisia tridentata*	5.1
American vetch	*Vicia americana*	5.0
Peavine	*Lathyrus leucanthus*	4.0
Wild rose	*Rosa spauldingii*	3.9
Bearded wheatgrass	*Agropyron subsecundum*	1.7
Sawtooth butterweed	*Senecio serra*	1.7
Yellow willow	*Salix lutea*	1.7
Fremont geranium	*Geranium freemontii*	1.5
Rabbitbrush	*Chrysothamnus nauseosus*	1.3

[3]The forage acre factor is an index to grazing capacity. It is obtained by multiplying the amount of vegetation in percent of ground cover by the quality of vegetation in terms of percent consumed under "proper" grazing.

Yellowbrush	*Chrysothamnus viscidiflorus*	1.3
Yarrow	*Achillea lanulosa*	1.3
Bitterbrush	*Purshia tridentata*	1.3
Bluegrass	*Poa spp.*	1.1
Sedge	*Carex rostrata*	1.0
Mountain brome	*Bromus carinatus*	1.0

When animals enter the pastures about July 1, vegetation is well developed every year and feed is superabundant. Generally, the weather in July and August is dry and hot, hence vegetation dries rapidly and in August is usually well browned and low in water content. Although September and October are much wetter months, little fall growth takes place. Leaves of shrubs and trees turn brown and drop, usually during the first two weeks of October.

The average chemical composition of the major forage species at the beginning and at the end of the grazing season is shown in table 2.

Table 2. *Weighted average composition (dry weight) of the pasture forage plants in percent, based on analysis of 24 major species and weighted according to percent of floral composition*

	Total ash	Crude protein	Crude fat	Crude fiber	Nitrogen-free extract	Phosphorus	Calcium	Calcium to phosphorus ratio
Beginning of season	7.59	18.89	3.45	15.59	55.05	.421	1.34	3.18
End of season	8.98	9.75	4.80	19.38	57.88	.439	2.25	5.13

Monthly analyses throughout the summer show decreasing protein, whereas fiber, nitrogen-free extract, and fat increase. The chemical studies indicate a high-quality feed, however, even in late season. No deficiencies are evident, and with the possible exception of a too high calcium to phosphorus ratio, the forage at all seasons compares favorably with standard livestock diets. Although protein drops from 18.89 percent in the early summer to 9.75 about October 1, it remains high enough for mature animals. This protein level is somewhat deficient for rapidly growing animals but the deficiency does not appear serious.

Supplemental salt (NaCl) was before the animals at all times and, in some years, a phosphorus supplement was also available. Salt consumed and lost by weathering averaged just over one pound per head per month. Only slight decreases were found in salt utilized as the season progressed.

Stocking rate has been at the level of 2.8 acres per animal per month in 1934, 1935, 1936, and 1937; about 2.2 acres in 1940, 1941, and 1942; 1.6 acres in 1943. In addition, an average of 40 head of deer are estimated to have summered on the pastures.

The Livestock

THE cattle used in these investigations were steers with the exception of a few heifers in 1943. The animals varied greatly in size, condition, and age. They were of Hereford breed with the exception of about 10 percent which were of Holstein, Shorthorn, and mixed breeding.

The animals were owned by various members of a local livestock association, hence were wintered at different levels of nutrition and were of varied breeding. Some animals were well-fed in yards during the winter whereas some were poorly fed, existing mostly on low-grade pasture and poor meadow hay. However, the animals were on range for a period of 6 to 8 weeks prior to entering the pastures, hence their weights were adjusted, at least in part, before they were used in the experimental work.

Ages of the animals varied from less than one up to three years and weights varied from 300 to 800 pounds. In the 8 years reported, data from 367 animals are included. Because of this large number and because of the variation in breed, age, and condition the data are considered applicable to average Utah steers (see fig. 3).

Weighing the Animals

The animals were weighed at the start of grazing on the pastures. This date ranged from June 20 to July 8. Thereafter, they were rounded up and weighed generally each 28 days until the end of the grazing season (fig. 4). This resulted in four periods of gain and five

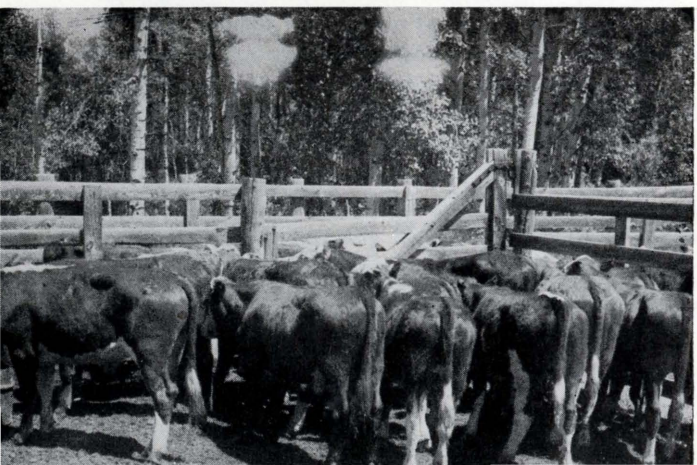

Fig. 3. Hereford steers in the holding corral prior to entering experimental pastures near Logan

Fig. 4. Each month cattle were rounded-up and weighed to determine rate of gain

weighings. During the last three years, the last period was usually only fourteen days; in 1940 it was omitted entirely. This schedule has resulted in a closing date of October 10 to 16 with the exception of 1940. Thus, although dates varied (table 3) the 4 periods correspond roughly to July, August, September, and early October.

Table 3. *Dates of cattle weighings during the eight years of study*

Year	First weight	No. of days	Second weight	No. of days	Third weight	No. of days	Fourth weight	No. of days	Fifth weight
1934	June 23	28	July 21	28	Aug. 18	28	Sept. 15	28	Oct. 13
1935	June 20	28	July 18	28	Aug. 15	28	Sept. 12	28	Oct. 10
1936	June 20	28	July 18	28	Aug. 15	28	Sept. 12	28	Oct. 10
1937	July 1	28	July 29	28	Aug. 26	28	Sept. 23	23	Oct. 16
1940	July 4	34	Aug. 7	29	Sept. 5	33	Oct. 7	....	None
1941	July 8	29	Aug. 5	30	Sept. 4	25	Sept. 29	14	Oct. 13
1942	July 8	27	Aug. 3	28	Aug. 31	28	Sept. 28	14	Oct. 12
1943	July 2	31	Aug. 2	28	Aug. 30	28	Sept. 27	17	Oct. 14

In order to stabilize body weight, animals were corralled and deprived of shade, water, and feed until the following morning, at which time they were weighed. Weights of a few animals indicate that the loss during this period was about 7½ percent of body weight. This loss, mostly resulting from emptying the stomach and bladder and from drying of the body tissue, would soon be regained when the animals were returned to the pastures.

In the years 1935, 1936, 1937, and 1943 blood samples were taken at the time of weighing to determine calcium and phosphorus level.

Animal Gains

GAINS of livestock on the pastures have varied greatly from month to month each summer and, also, individual years varied greatly. This is to be expected when one examines the variation in weather from year to year as shown in figure 1. Although average gain has been 1.57 pounds per head per day, there have been gains of individual animals as high as 6.4 pounds per day during a single month and losses as high as 4.0 pounds per day. In one instance, a lot of 20 steers averaged a daily gain of 3.6 pounds per head per day for a month and in another instance a lot of 37 animals lost 1.9 pounds per head over a two-week period in October.

Average gains by month over the eight years of study are shown in table 4.

Table 4. *Average weight gains of steers* on summer pasture in northern Utah in pounds per head per day*

Year	No. of animals	Initial weight	Gain during†				Gain average for the season	Gain in percent of initial weight
			July	Aug.	Sept.	Oct.		
		pounds	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	
1934	20	549.0	1.77	1.80	.68	.40	1.16	23.67
1935	40	520.5	1.88	3.11	.62	1.80	1.84	39.63
1936	40	560.0	2.78	1.73	2.39	.75	1.96	38.87
1937	40	538.2	2.94	2.06	1.61	1.20	1.97	40.02
1940	55	672.1	2.47	.50	1.58	.....	1.61	23.77
1941	54	601.1	1.41	1.99	1.22	—1.01	1.18	17.98
1942	51	592.7	.96	2.20	.53	1.40	1.28	22.04
1943	67	580.8	2.13	2.01	1.02	.85	1.58	28.47
Average		576.8	2.05	1.93	1.21	.77	1.57	29.03

*Including 14 heifers in 1943.

†The time-periods involved are somewhat variable, but generally are from July 1 to October 15, and are divided into 4-week intervals, except for the last interval which was generally 2 to 4 weeks long.

Effect of Season Upon Gains

Average rate of gain decreased regularly as the season progressed although the difference between July and August is not great. The averages found were 2.05 pounds per day in July, 1.93 in August, 1.21 in September, and 0.77 in early October. Since the period of this study covered years of extreme drought and years of far above normal

precipitation, and since the animals varied greatly in breeding, size and condition, these averages should be reasonably indicative of what northern Utah ranchers can expect from high-class summer ranges. Although this is the "usual" expectation and is about what is expected of the average year, actual performance varies greatly from year to year. Table 4 shows four years worthy of special attention, 1935, 1940, 1941, and 1942.

The years 1935 and 1942 are somewhat comparable in that August gains were higher than July, and October gains were higher than September gains. The year 1940 was unusual because of the very low gains in August. The year 1941 is outstanding because of the severe weight loss which occurred in October.

Such variation is explained with difficulty after it has been discovered; forecasting deviations from the normal is even more difficult. Certain rules should be kept in mind in analyzing such reactions.

(1) Low gains are likely to be followed by high gains and vice versa since a growing animal tends to adjust its weight rapidly to the "normal." Thus, livestock feeders know that, if in good health, thin cattle will gain faster than better fleshed animals and animals that enter the feed lot in good condition are likely to show less gain. Therefore, a high gain in table 4 may be explained by a low gain in the previous period rather than by extra favorable conditions during the current period.

(2) Animals may gain slowly when the weather is very hot or they may gain slowly when it is very cold, especially if it is cold and wet. This poor response results from cessation of normal grazing activity.

(3) Subnormal gains may result from poor forage condition on the range. Thus, a cold spring, even though wet, will result in poor growth of vegetation. Abnormal drought, especially when coupled with high temperature, will cause production of green material to cease and old growth will become dry and brown. In this event, the nutritive value decreases and, further, the palatability decreases, resulting in two things: consumption of less feed and less gain per pound of feed consumed.

(4) It appears that poor gains result not only from poor plant growth, a fact well known, but also from extremely rank plant growth. Presumably when weather is ideal and vegetation becomes rank, it is low in protein and phosphorus and high in fiberous material. In addition, it may mature early, resulting in an "early" fall. Even though available in superabundance, this low quality herbage results in poor animal performance. Such a condition existed in 1941, when severe

fall losses occurred. This situation has been reported elsewhere in 1941 with similar effect upon livestock.[4]

The year 1935 was marked by record-breaking drought during the summer, but rains in April and May resulted in good vegetation growth. July, with no rain and above average temperature, resulted in below normal gain. August gains were very high and resulted apparently from reduced temperature, slight though appreciable rain, and a gain-potential carried over from a poor performance in July. These favorable factors, however, are not sufficient to explain the extremely high gain obtained. The low September gain, of course, was expected after a high August gain, and in view of the severe drying of vegetation resulting from the record-breaking drought from June through September.

In 1942, unusually low spring temperature (table 1) made plant development noticeably later than in any other year of the study. This, coupled with severe drought and unusually high temperature in July, resulted in much the poorest July gain during the study. An improved gain in August again can be explained by a gain-potential carried over from the poor July performance, above average August precipitation, and reduced temperature.

In 1940, gains in August were very low; September gains, in turn, were well above normal. A glance at figure 1 shows August to be without rain and much above normal in temperature. Relief from this situation came in September with extremely heavy rains and much reduced temperature. This, together with a gain-potential carried over from August, resulted in gains well above normal in September.

Late fall is much the most important season for producers to watch their range land and their livestock. As already mentioned, 1941 resulted in weight losses of extreme severity in early October. Much income loss could have been avoided had ranchers marketed in August. Conversely, in 1935, 1937, and again in 1942, good gains were recorded in late fall. Marketing in August would not have been desirable in these years.

In 1941, the loss of weight in October can be attributed to several factors which by coincidence combined to make conditions markedly unfavorable. The first, already referred to, was unusually heavy precipitation throughout the season, resulting in rank vegetation growth,

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[4]See:

(1) Feeding value of New Mexico range grasses in the fall of 1941. New Mexico Agr. Exp. Sta. Press Bul. 935. mimeo.

(2) Salt-bonemeal mixture used by breeding cows on shortgrass ranges during four summer and three winter seasons. Northern Rocky Mountain Forest and Range Experiment Station Res. Note 32. 1944. mimeo.

(3) Range management research, preliminary results. Rocky Mountain Forest and Range Experiment Station. 1943. mimeo.

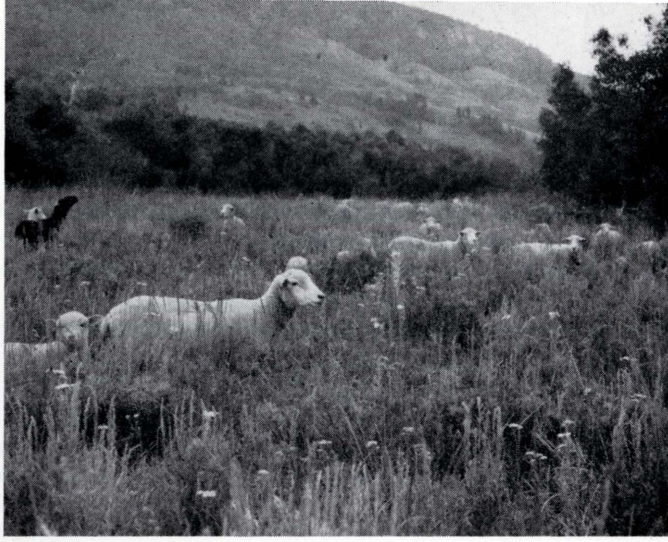

Fig. 5. In 1941, forage was produced in great abundance, but proved to be of poor quality

low in nutritive value and low in palatability (see fig. 5). Equally important was the very low temperature in September and October. October was marked also by heavy rainfall and some snow. Weight losses among steers in October were severe. Vegetation records on the pastures show a superabundance of forage remaining after the grazing season, much of the range appearing to be untouched. However, the advanced season resulted in most of the leaves of deciduous plants dropping by September 29.

Conversely, 1937 was warmer than average in September and October, and rainfall was about normal. Although October was normally cold in 1935 and 1943, it was much drier than normal. In both of these years, especially in 1935, September was warm and relatively dry. In all of these years, fall rains were excellent.

Effect of Size Upon Gain

As pointed out, there was great variation in the size of animals on the pastures each year. Although to some extent condition of livestock affected their beginning weight, the major factor involved was age. To determine the effect of the beginning weight upon animal gains, the data each year were calculated as follows: The gains of the heaviest and those of the lightest half of the animals in each pasture were averaged. The results by years, together with the average weight of each group, are shown in table 5.

The relative season-long gains in pounds per head per day varied slightly in the two groups from year to year but, over the eight years involved, there was a relatively small difference of 0.05 pounds per head per day or roughly 5 pounds per head for the season. Since the smaller animals averaged some 150 pounds less at the start of grazing,

Table 5. *Average weight gains of steers on summer pasture in northern Utah in pounds per head per day when divided into two groups consisting of the half having greatest initial weight and the half having the least initial weight*

Lighter animals

Year	Initial weight	Number of animals	July	Aug.	Sept.	Oct.	Season long	Percent of starting weight
1934	486.5	10	1.80	1.62	.91	.32	1.16	26.82
1935	446.8	20	1.75	3.08	.80	1.99	1.85	46.44
1936	507.0	20	2.82	1.88	2.37	.93	2.03	44.97
1937	462.7	20	2.89	2.12	1.60	1.52	2.01	46.61
1940	589.7	16	2.33	.69	1.74	.....	1.77	28.27
1941	518.1	25	1.14	1.98	1.25	—.87	1.16	21.84
1942	504.7	24	.96	2.14	.76	1.40	1.22	25.31
1943	497.5	34	1.99	1.93	1.02	1.05	1.56	32.15
Average	501.6	....	1.96	1.93	1.31	.91	1.59	34.05

Heavier animals

Year	Initial weight	Number of animals	July	Aug.	Sept.	Oct.	Season long	Percent of starting weight
1934	611.5	10	1.73	1.98	.45	.48	1.16	21.26
1935	594.2	20	2.07	3.13	.43	1.60	1.81	34.24
1936	613.1	20	2.72	1.60	2.45	.66	1.86	34.05
1937	613.6	20	3.01	2.00	1.62	.90	1.92	33.54
1940	760.0	15	2.63	.34	1.43	.....	1.44	17.23
1941	684.1	25	1.61	2.00	1.18	—1.12	1.20	17.80
1942	676.9	24	1.24	2.19	.35	1.38	1.34	19.71
1943	664.2	33	2.29	2.10	1.01	.77	1.62	25.01
Average	652.2	....	2.16	1.92	1.11	.68	1.54	25.36

the difference in terms of "percent gain" is very significant.[5] Lightweight animals averaged a 34.05 percent gain; heavy animals averaged but 25.36 percent. An important question to the producer is which of these is more important, pounds of gain or percent of gain? Since he markets "pounds" and not "percent," the producer is likely to consider pounds gain only. This appears, however, to be poor policy for the following reasons.

Although there is uncertainty as to the relationship between size of an animal and his maintenance requirement, it is certain that a large

[5]Percent gain is gain expressed as percent of initial or starting weight.

steer requires more feed than a small steer. Body weight likely is not a direct index to forage requirement; however, most feeding standards are based upon body weight, and in general, feed-lot studies show weight to be a fairly reliable index to feed requirements. Although body surface has been proposed as a better basis,[6] and undoubtedly is a factor involved, weight appears to be sufficiently accurate for general usage. In light of this reasoning, then, a given range unit will support more small steers than large. Calculating on the basis of 650-pound versus 500-pound animals as reported in table 5, a range could support approximately 100 animals of 650 pounds as compared to 130 animals of 500 pounds. The 100 large animals would net a calculated 15,400 pounds gain in a 100-day summer season; the 130 smaller animals would net 20,020 pounds.

This indicates that larger and older steers are less efficient in digesting range forage and that for best production small steers are desirable. The practice of keeping spring calves past the long-yearling stage likely is not conducive to highest returns from a given range unit.

Effect of Size Upon Season of Gain

An interesting difference in rate of gain for different sized steers is shown in table 5. July gains were greatest for heavy animals by 0.20 pounds per day per head or 5½ pounds per animal in the first month. August gains did not differ between the two groups but September and early October gains without exception were greater in smaller animals. Average differences in pounds per head per day were 0.20 in September and 0.23 in October.

This agrees with accepted theory that animals, as they approach maturity or maximum weight, tend to gain less rapidly. The large animals do not do so well on ranges in late fall. This points to the desirability of removing larger steers from the range earlier in the fall than would be true for smaller steers.

Season to Market

THE ideal season to market cattle from range lands varies from year to year. Although as a general rule gains decrease during the summer as the season progresses, this is not always the case. For example, in 1935 and in 1942, gains of 1.84 and 1.40 pounds per head per day were registered in the last month of the season (table 4). Obviously, early marketing in these years would be unwise. Converse-

[6]Brody S., R. C. Proctor, and V. S. Ashworth. Growth and development with special reference to domestic animals. XXXV. Basal metabolism, endogenous nitrogen, creatinine and neutral sulphur excretions as functions of body weight. Mo. Agr. Exp. Sta. Res. Bul. 220. 1934.

ly, in 1941, when an average loss of a pound per head per day was recorded in early October, early marketing would have saved producers great financial loss. Progressive stock growers must be able to recognize these seasons and should watch both cattle and ranges closely.

General marketing policy, however, should be based upon average livestock performance. Average gain in early October (table 4) was 0.77 pounds per head per day. Although first thought may suggest that so long as an animal is gaining it should be left on the range, this is not necessarily fact.

An animal which is a part of the breeding herd or is a young animal to be kept over for another summer's grazing period either for marketing or for use in the breeding herd may remain on summer range even though it has ceased gaining provided feed is plentiful and the range is not being overgrazed. Fall use on ranges is least harmful since vegetation has matured. However, producers should not feel that this grazing is obtained at no cost to the range and certainly over-use should not be practiced even in the fall. The concentration of stock in bottom lands which results from cold and snowy weather is damaging to these spots and should be avoided by herding or by removal of the animals from the range. Weight gains appear to cease as soon as snow falls, and removal from the range is desirable.

An animal which is to be marketed should be removed from the range before he loses weight. Under almost no condition of market price increases could a producer afford to allow animals to lose weight. Generally, marketing feeder animals is desirable in the fall well before gains cease. Usually, the market for feeder and stocker animals declines slightly throughout the summer and fall months (see fig. 6). In addition to rate of animal gain and estimation of market trend, the period of marketing direct from the range should be determined by:

1. Amount of range feed.
2. Price of range use.
3. Level of market.
4. Long-time trend of market.

In the event that a producer has farm feeds available, he has the advantage, of course, of the alternate choice of feeding for a period in the feed lot to increase weights or to hold out for better prices.

Amount of Range Feed

If range feed is scarce and steers or other marketable animals are retained, they consume forage which otherwise remains for the breed-

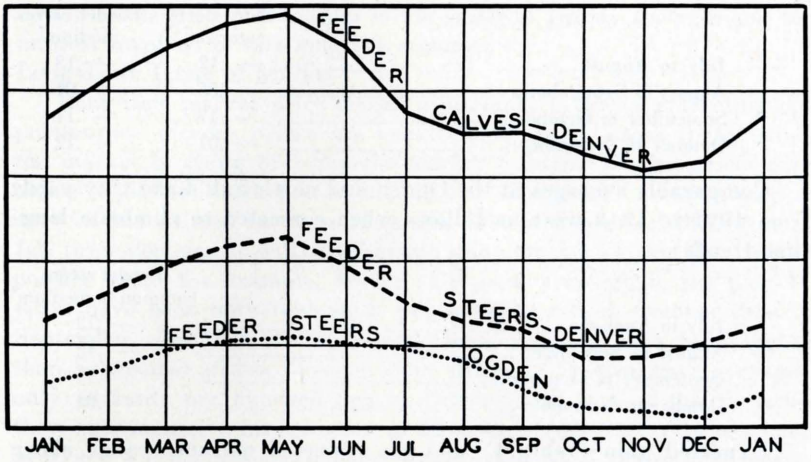

Fig. 6. Price trends at livestock markets in Denver and Ogden. Denver prices cover the period of 1932 to 1942. Ogden prices cover the period of 1924 to 1943. The horizontal lines indicate a price differential of 50 cents per hundredweight. Levels between Denver and Ogden prices do not indicate higher prices at Denver since the time period involved is different

ing animals which must be maintained yearlong. Scarcity of forage is one of many factors which bring about weight declines in late summer. Choice forage becomes rare and animals are forced onto secondary feed. The more animals using a given range unit, the sooner this condition comes about. Therefore, if marketable animals are removed early, even at some sacrifice in weight, the loss may be compensated by better gains and better performance by the remaining animals. Conversely, if forage is plentiful by virtue of conservative stocking or extraordinary plant growth, then marketable animals may be retained until the most profitable market price—animal weight relationship exists.

Price of Range

Good economics dictates, of course, that when a producer pays for grazing by the month or when heavy use of grazing land will force him to the use of costly supplemental feed earlier, then the gains of marketable animals should be weighed against the cost of obtaining those gains. Monthly changes in the Denver market are subject to great variation. However, average prices received from 1933 to 1942, when adjusted to compensate for a gradually increasing price throughout the period, show the following changes in dollars per hundredweight:

	Feeder steers common[7]	Feeder calves medium[7]
July to August	— .12	— .13
August to September	— .05	+ .01
September to October	— .17	— .11
October to November	— .01	— .12

Comparable averages at the Ogden and north Salt Lake City yards from 1924 to 1943 were as follows when corrected to eliminate long-time trends:

	Feeder steers common to medium[8]
July to August	— .12
August to September	— .12
September to October	— .11
October to November	— .04

Expected gain (table 4) and the expected market change above can be used to calculate approximate differences in income which might result from marketing September 1 as compared to October 1. The cost of grazing during September should be covered by a corresponding increase in income plus a small margin to cover risk and interest on the investment.

Level of Market

When market prices are high, producers ordinarily can afford to keep marketable animals later in the fall since the price received for each pound of gain is greater. For example, at Denver marketing steers in September rather than October might be expected to result in a market some 17 cents higher per hundred. Assuming an average gain from such a steer, he would weigh (table 4) 576.8 pounds on July 1, 705.1 pounds on September 15, and 734.8 pounds on October 15. Considering expected market decline, the following prices would be received for the steers at various market prices:

Price Sept. 15	Receipts Sept. 15	Price Oct. 15	Receipts Oct. 15	Receipt Difference
$15.00	$105.76	$14.83	$108.97	$3.21
10.00	70.51	9.83	72.23	1.72
5.00	35.25	4.83	35.49	.24

Obviously, at a high market, the additional income from keeping marketable animals late in the fall is worthwhile. At low market,

[7]Original data from monthly average price reports computed by the U. S. Bureau of Agricultural Economics, Livestock Meats, and Wool Division.

[8]Original data from classified quotations of the U. S. Department of Agriculture Market News Service, Ogden, Utah.

however, the price differential is too small to justify the risk and the interest involved in retaining the animals.

Long-Time Trend of Market

Long-time market price trends profoundly influence marketing opportunities. Feeder prices are usually close to fat-stock prices when the market is rising or when the market is high. Feeder prices may almost equal fat-stock prices under these conditions. A rising market such as has existed between 1934 and 1943 will not feel the effect of fall price declines as will a stable or falling market. Using the Denver market again for example, feeder calf price averages in the past 10 years have been only four cents per hundred less in October than in September. In 5 of the 10 years, October prices have been higher than September prices. Feeder steer prices in Denver have averaged only 13 cents per hundred less in October and in 4 of the 10 years they have actually been higher in October. Ogden steer prices have averaged 5 cents less in October; however, in 10 of the past 20 years, October prices have been as high or higher than September prices.

Heifer Weights Compared to Steers

IN 1943, fourteen open yearling heifers of dairy breeds, mostly Holstein, were placed in the pastures to compare to beef-breed steers. This test was conducted to determine the wisdom in the common practice in northern Utah of placing dairy animals on the range during their second summer. Although the number of animals used was not sufficient to give conclusive data, the results were of interest. The weights are shown in table 6.

Table 6. *Average gains by month for dairy-breed heifers compared to beef-breed steers in pounds per head per day while on rough summer range*

	No. of animals	Initial weight	Gain during				Season-long gain	Gain in percent of initial weight
			July	Aug.	Sept.	Oct.		
		pounds	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	
All animals	67	581	2.13	2.01	1.02	.85	1.58	28.47
Beef steers	53	615	2.40	2.12	1.02	.92	1.73	29.04
Dairy heifers	14	446	1.03	1.57	1.02	.59	1.14	26.73

Although there was about 50 pounds per head less gain for the heifers compared to the steers, their lesser weight resulted in a gain in percent of initial weight almost equivalent to that of the steers, 26.73 precent compared to 29.04 percent. Reference to table 5, how-

ever, will show that animals of lesser initial weight should gain materially more in terms of percent of initial weight. Beef steers of the same weight would have been expected to gain some 36 percent as contrasted with 26.73 percent gained by dairy heifers. It is concluded, then, that the heifers were definitely less efficient than beef steers of the same weight in meat production.

Heifers were found to be highly variable in gains. For example, weights a few days after a heat period were low, heavy losses being common. However, some weeks after the period, normal weights were found, indicating a rapid regain of weight lost during the heat period. As was true also of steers, some gained much better than others. Several gained in excess of 45 percent of initial weight, and one animal weighing but 245 pounds at the start of the grazing season gained over 55 percent of her initial weight.

Dairy-Breed Steers Compared to Beef Steers

In 1940, 1941, and 1942, a total of 13 Holstein and 13 Shorthorn steers were grazed along with Hereford steers. Again the numbers were not sufficient for statistically valid comparison, but the weights shown in table 7 may be of interest.

Table 7. *Average weight gains of steers on mountain summer range by breed*

Breed of steer	No. of animals	Average initial weight	Average gain in 3½ months	Gain in percent of initial weight
		pounds	*pounds*	
Hereford	107	600.8	128.9	21.45
Holstein	13	674.1	109.0	16.16
Shorthorn	13	607.6	130.0	21.39

The Shorthorn and Hereford steers showed no significant difference but Holstein steers consistently showed much lower gains, the difference averaging about 20 pounds per head for the season. Holstein steers weighed some 70 pounds heavier at the start of grazing, and based upon percent of initial weight, gained only 16.16 percent compared to well over 21 percent for Hereford and Shorthorn steers.

It is very likely that the dairy-breed steers would not grade so well nor bring so high a market price as Herefords. It should be remembered, however, that dairy heifers are not raised for meat, hence their desirability should be measured in terms of their value as a dairy cow rather than in terms of meat gains. Their value may greatly ex-

ceed that of a much heavier beef animal. Nevertheless, except in dairy communities where special conditions necessitate range use by dairy stock, it appears that a much more economic use can be made of range land by use of good-grade beef animals. The common thought on the part of beef growers that dairy heifers will not grow on rough range lands appears to be fallacious but the wisdom of using the already scarce range land for growing-out large numbers of dairy heifers might be questioned because of its greater value in production of meat animals. Further work is needed to show whether dairy-breed steers should be grown-out for beef and whether they can be maintained more economically on farms or on range lands.

Effects of Phosphorus Supplement

DEFICIENCY of phosphorus is common on western ranges, especially during the fall and winter after vegetation has matured. For this reason, animals in one pasture were supplemented with phosphorus during four of the eight years reported herein. In 1935, 1936, and 1937 one group was given free access to an equal mixture of bone-meal and sodium chloride. The quantity of bone-meal consumed was not determined. The animals in the other pasture were given only sodium chloride. In 1943, one group was given free access to technical grade anhydrous mono-sodium phosphate in equal mixture with sodium chloride. Chemical analysis of vegetation showed an average of 0.430 percent phosphorus in the pasture forage. While this amount of phosphorus should be adequate for any grazing animal, the average calcium content of 1.79 percent gives a calcium to phosphorus ratio of 4.15 which is uncommonly high, a ratio of 1.0 or 2.0 being considered ideal. This ratio reaches a level of 5.13 in the pastures in late summer. This ratio should not prove prohibitively high since the phosphorus level is high and since vitamin D is presumably at a high level on summer range. However, since excess calcium tends to render phosphorus non-available to livestock, it was felt that despite an apparent adequacy of phosphorus, animals might be deficient. This reasoning prompted the shift from bone-beal supplement, which contains calcium as well as phosphorus, to the mono-sodium phosphate which contains no calcium.

To measure the effectiveness of these supplements, blood samples were taken from animals at each weighing in 1935, 1936, and 1937. The samples were analyzed for calcium and phosphorus. In 1943, blood was collected at the last three weighings and analyzed for phosphorus only. The blood analysis data for the first 3 years are shown in table 8. A level below approximately 4.0 to 5.0 milligrams per 100 cc of blood plasma is considered to indicate phosphorus deficiency,

Table 8. *Analysis of blood samples from grazing steers showing average phosphorus and calcium in milligrams per 100 cubic centimeters of serum*

Year	Supplemented						Unsupplemented					
	June	July	Aug.	Sept.	Oct.	Average	June	July	Aug.	Sept.	Oct.	Average
PHOSPHORUS												
1935	5.20	4.98	4.95	5.39	3.86	4.88	5.32	5.12	5.09	5.10	3.71	4.87
1936	4.83	5.19	4.75	5.39	5.17	5.07	4.85	5.49	4.56	5.10	4.50	4.90
1937	3.36	4.55	4.25	3.48	3.12	3.75	3.56	3.99	4.25	3.46	3.13	3.68
Average	4.46	4.91	4.65	4.75	4.05	4.56	4.58	4.87	4.63	4.55	3.78	4.48
CALCIUM												
1935	10.8	11.6	11.6	10.3	10.4	10.9	11.1	11.6	11.6	10.1	10.6	11.0
1936	10.3	10.1	10.4	10.1	10.6	10.3	10.1	10.3	10.1	10.2	10.6	10.3
1937	10.6	10.1	10.5	10.8	.....	10.4	10.4	10.6	10.5	10.9	.....	10.6
Average	10.6	10.6	10.8	10.4	10.5	10.5	10.5	10.8	10.7	10.4	10.6	10.6

although young animals usually have a somewhat higher level. Calcium content of blood generally is between 9 and 12 milligrams. Although phosphorus in the blood increased during the first month animals were on the pastures, there was a definite downward seasonal trend, especially in the last month. Attempts to prevent this decline by bone-meal were only partially successful. Average differences were found in favor of the supplemental group of 0.20 milligrams in September and 0.27 in October. Actually, in 1936 the difference was 0.67 at the close of the season; in 1937 there was no difference. Statistically, these inter-group differences are not significant with the exception of 1936 when the difference was highly significant.

Blood calcium showed no seasonal trend nor was there any significant difference between the two groups. Lack of seasonal trend in blood calcium is of interest in view of the very significant increases found in calcium content of the range forage as the season progressed; 1.34 percent at the start of grazing and 2.25 at the end.

No significant increase in gains of livestock accompanied bone-meal supplement.

In 1943, mono-sodium phosphate was fed to one group of animals. Consumption averaged 1.44 grams of phosphorus per day per head. Inorganic phosphorus was found in the blood serum in milligrams per hundred cubic centimeters as shown in the following averages:

	August	September	October
Supplemented	5.61	5.65	5.66
Unsupplemented	5.02	5.08	4.81

The differences found between the two groups are highly significant statistically. Although the data are not sufficient for wide generalizations, the mono-sodium phosphate appeared to be more effective in maintaining phosphorus level of the blood in the fall than was bonemeal supplement. There was, however, still no increase of gain accompanying the supplemental feeding of phosphorus, hence it is concluded that phosphorus supplement is not necessary on northern Utah summer ranges. This conclusion agrees with conclusions made after comprehensive study of chemical composition of range forage.[9]

Summary

1. For eight years the Utah Agricultural Experiment Station has grazed cattle on experimental summer ranges in the high mountains of northern Utah. This bulletin is a report on livestock gains, factors which affect the gains, and the effect of the gains upon season to graze and season to market livestock. The effect of phosphorus supplements upon blood phosphorus and animal gains is also reported.

2. Steers were found to gain an average of 2.05 pounds per head per day in July, 1.93 in August, 1.21 in September, and 0.77 in early October, the season-long average being 1.57 pounds per day. Season-long gains averaged 29.03 percent of initial weight.

3. Great variation in seasonal gains occurred. In general, low gains were made when vegetation was poorly developed because of spring cold or drought and also when vegetation made unusually rank growth, poor quality resulting. Low gains in late summer were associated with low temperatures, especially when wet and snowy. Prolonged drought and high temperatures in midsummer resulted in low quality of vegetation and suspension of normal grazing activity of the animals; poor gains followed.

4. Size of steer influenced gains. Larger animals, usually older, gained significantly less in late summer than smaller animals. Larger animals (652.2 pounds initial weight) over an eight-year period gained 1.11 and 0.68 pounds per head per day in September and early October, compared to 1.31 and 0.91 pounds for smaller animals (501.6 pounds initial weight). Although the pounds gained per head over the season did not differ significantly, smaller animals gained an average

[9]Stoddart, L. A. and J. E. Greaves. The composition of summer range plants in Utah. Utah Agr. Exp. Sta. Bul. 305. 1942.

of 34.05 percent of their initial weight compared to 25.36 percent for larger animals. Since larger animals are believed to consume more feed, but since they did not gain more per head, smaller animals are considered more efficient in converting forage to meat.

5. Average prices of feeder and stocker animals decline rather regularly from May to November, but the decline is not rapid. The fall marketing season, most desirable for animals to be marketed direct from the range, depends upon amount of feed remaining on the summer range, rate of livestock gains, trend of the market, and current level of the market. Under average conditions of market trend and animal gain, early marketing appears economical when feed is scarce or when market prices are low. Growers must analyze range and livestock conditions carefully to determine the most economical marketing policy each year.

6. Dairy-breed heifers and Holstein steers were found to gain much less efficiently than Hereford steers, although all made significant growth on mountainous summer range. Although dairy-breed heifers did not gain so well as beef steers, they did make satisfactory growth and development for dairy breeding heifers.

7. Supplementing phosphorus in the form of bone-meal and mono-sodium phosphate did not influence gains significantly. Bone-meal induced significantly higher blood phosphorus in only one of three years. Mono-sodium phosphate resulted in significantly higher blood phosphorus at all seasons tested. Chemical analysis showed significant decrease in phosphorus in the blood serum as season progressed, but calcium showed no seasonal trend. Because of the high phosphorus average in the forage (0.430 percent) and because gains did not increase with phosphorus supplement, it is concluded that addition of phosphorus to the diet was not necessary on this experimental summer range despite rather low blood phosphorus levels in late summer.

College series no. 688